DOCUMENT RESUME

ED 152 563 SE 024 096

AUTHOR Petrasek, Al, Jr.
TITLE A Guide for Developing Standard Operating Job Procedures for the Tertiary Chemical Treatment - Lime Precipitation Process Wastewater Treatment Facility. SOJP No. 6.
INSTITUTION Charles County Community Coll., La Plata, Md.
SPONS AGENCY Environmental Protection Agency, Washington, D.C. Div. of Manpower Training.
PUB DATE Feb 75
GRANT EPA-900253
NOTE 185p.; For related documents, see SE 024 091-097; Contains occasional light and broken type

EDRS PRICE MF-$0.83 HC-$10.03 Plus Postage.
DESCRIPTORS *Guides; Health Occupations; Industrial Training; *Job Training; Safety; Technical Reports; *Utilities; *Waste Disposal; Water Pollution Control; *Water Resources

ABSTRACT

This guide describes the standard operating job procedures for the tertiary chemical treatment - lime precipitation process of wastewater treatment plants. Step-by-step instructions are given for pre-start up, start-up, continuous operation, and shut-down procedures. In addition, some theoretical material is presented along with some relevant chemical and mathematical computations. (BB)

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**6**

**SOJP NO 6**

**TERTIARY CHEMICAL TREATMENT-LIME PRECIPITATION PROCESS**

## A GUIDE FOR THE DEVELOPMENT OF

# STANDARD OPERATING JOB PROCEDURES

## FOR WASTE WATER TREATMENT PLANT UNIT OPERATIONS

**DEVELOPED BY**
**CHARLES COUNTY COMMUNITY COLLEGE**
**LA PLATA, MARYLAND**

**GRANT NO 900253**
**MANPOWER DEVELOPMENT STAFF,**
**ENVIRONMENTAL PROTECTION AGENCY.**

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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STANDARD OPERATING JOB PROCEDURE VI

# TERTIARY CHEMICAL TREATMENT - LIME PRECIPITATION PROCESS

DALLAS ENVIRONMENTAL ENGINEERING TRAINING CENTER

by

AL PETRASEK, JR.

FEBRUARY 1975

Process: TERTIARY CHEMICAL TREATMENT - LIME PRECIPITATION PROCESS

1. Operation Objectives
2. Brief Description of Processes

## 1. OPERATION OBJECTIVES

Since this unit operation can make very dramatic improvements in water quality, there are many objects which the process should achieve if operating properly. The quality improvements that should be realized can be broken down into three broad categories: physical, chemical and biological. The same three categories can be utilized to define the process objectives.

### PHYSICAL QUALITY OBJECTIVES

1. Almost complete removal of suspended solids.
2. Reduction of effluent turbidity to very low levels.

### CHEMICAL QUALITY OBJECTIVES

1. Almost complete removal of phosphorus.
2. Removal of all but the soluble BOD, COD, and TOC.
3. Removal of particulate nitrogen compounds.
4. Removal of some toxic metals.

### BIOLOGICAL QUALITY OBJECTIVES

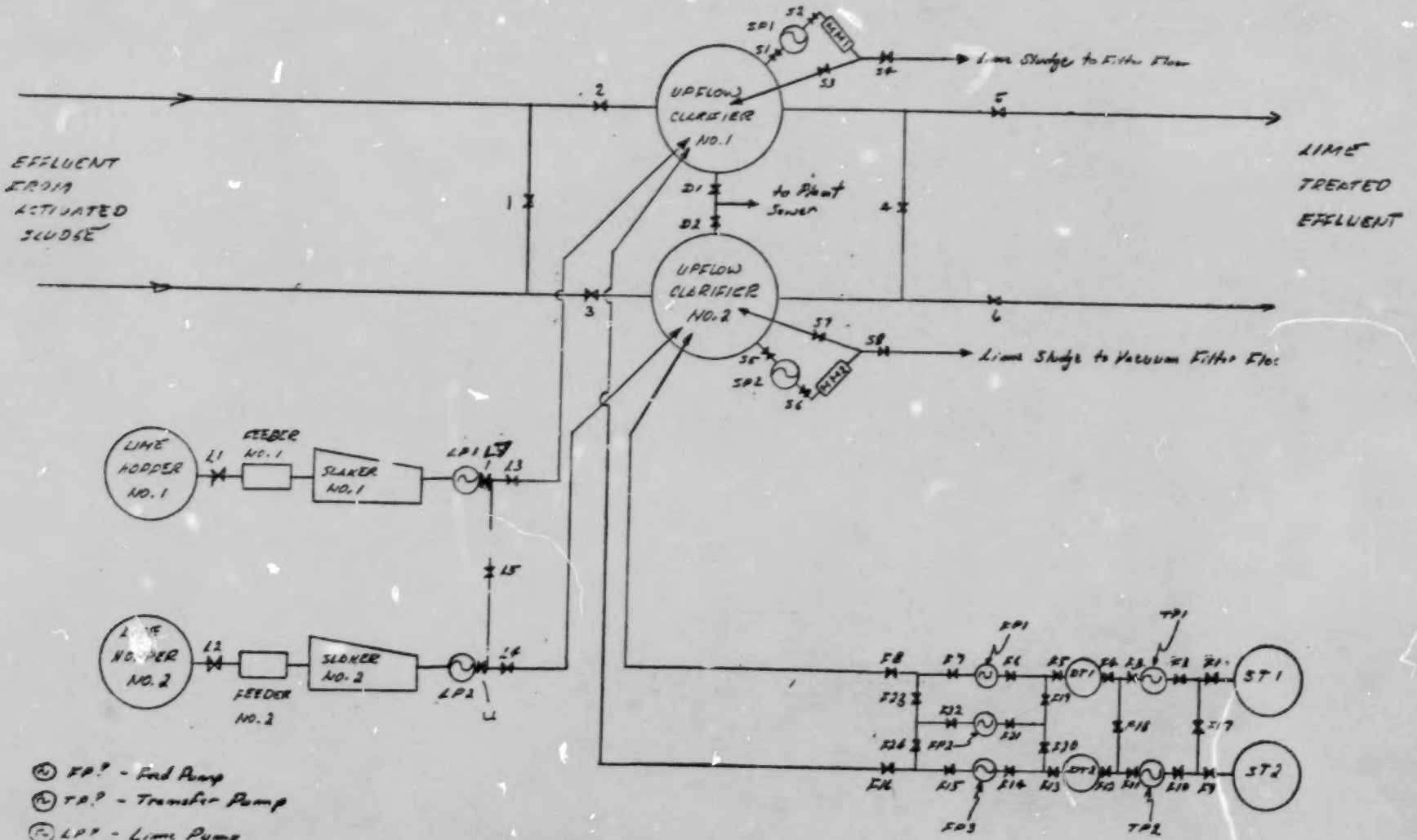
1. To achieve a complete kill of coliform and fecal coliform organisms.
2. To affect an almost complete kill of all bacteria.
3. To affect an almost complete kill of parasitic organisms such as amoeba and nematodes.
4. Complete removal or inactivation of viruses.

## 2. DESCRIPTION OF PROCESS

Chemical treatment is a three-step process in which the water is coagulated, flocculated, and settled. Lime and a flocculation aid (such as a polymer or ferric chloride) are mixed with the secondary effluent in the rapid mixing zone. The purpose of rapid mixing is to quickly mix the effluent, coagulant, and flocculation aid so that the coagulation reactions go to completion quickly.

The purpose of the flocculation zone is to bring together the smaller particles so that they can grow into larger particles, or floc. The amount of mixing in the flocculation zone is very important to proper operation of the unit process. After flocculation has occurred, the water then enters a clarification zone in which the floc settles to the bottom of the tank and the clarified water passes over effluent weirs on the top of the basin.

Some of the sludge which settles to the bottom of the basin is pumped back to the flash mixing compartment to increase the solids concentration to a level between 20,000 and 40,000 mg/l. The high solids concentration in the flash mixing compartment and flocculation zone is the major reason for the terminology of "solids contact," another frequently used term is "slurry pool reactor."


EFFLUENT FROM ACTIVATED SLUDGE
UPFLOW CLARIFIER NO. 1
UPFLOW CLARIFIER NO. 2
to Plant Sewer
Lime Sludge to Filter Floor
Lime Sludge to Vacuum Filter Floor
LIME TREATED EFFLUENT
LIME HOPPER NO. 1
LIME HOPPER NO. 2
FEEDER NO. 1
FEEDER NO. 2
SLAKER NO. 1
SLAKER NO. 2
ST 1
ST 2
FP? - Feed Pump
TP? - Transfer Pump
LP? - Lime Pump
Valve on Flocculation Aid Lines
Valve on Sludge Lines
Valve on Drain Lines
Magnetic Flow Meter

Process: TERTIARY CHEMICAL TREATMENT - LIME PRECIPITATION PROCESS

General Description of Equipment Used in the Process

PROCESS EQUIPMENT DESCRIPTION

Tertiary chemical treatment occurs in a solids contact upflow clarifier, sometimes referred to as a slurry pool reactor. The basin has three compartments: Flash mixing, flocculation, and clarification. The flash mixing and flocculation zones each have a variable speed mixer to provide the necessary energy input for mixing. A sludge cutter bar, extending the entire diameter of the basin, revolves just above the tank bottom to prevent sludge accumulation and caking.

Lime, the primary coagulant, is stored in dual hoppers as calcium oxide (CaO). Weighted belt gravimetric feeders meter the quick lime (CaO) into paste slakers which convert the quick lime into hydrated lime ($Ca(OH_2)$). The slakers are equipped with paddles and rakes for mixing, and grit removal equipment. Water addition, which is required for slaking, is controlled by a torque accuated valve. After slaking, the lime slurry is pumped to the solids contact, up-flow clarifier by progressive cavity pumps.

The flocculation aid, ferric chloride, is stored in three rubber lined tanks and transferred to either of two day tanks before being pumped to the rapid mixing zone by positive displacement, diaphram metering pumps.

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| OPERATING PROCEDURES | STEP SEQUENCE | INFORMATION-OPERATING GOALS-SPECIFICATIONS | TRAINING GUIDE NOTE |
|---|---|---|---|
| A. PRESTART UP PROCEDURES | | | |
| 1. Safety Inspection of Up-Flow Clarifiers | 1. Inspect influent valves 1, 2, and 3. | 1. Closed, locked, tagged. | XII-1 |
| | 2. Inspect effluent valves 4, 5, and 6. | 1. Closed, locked, tagged. | |
| | 3. Inspect drain valves D1 and D2. | 1. Closed, locked, tagged. | |
| | 4. Inspect valves S1, S2, S3, S4, S5, S6, S7, and S8 on return and waste sludge lines. | 1. Closed, locked, tagged. | |
| | 5. Inspect breakers on motor control centers for return sludge pumps SP1 and SP2. | 1. Off, locked, tagged. | |
| | 6. Inspect breakers on motor control centers for rapid mixer drives. | 1. Off, locked, tagged. | |
| | 7. Inspect breakers on motor control centers for flocculation. | 1. Off, locked, tagged. | |

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| A. PRESTART UP PROCEDURES | | | |
| | 8. Inspect breakers on motor control centers for sludge sweeps. | 1. Off, locked, tagged. | |
| | 9. Inspect breakers for magnetic flow meters on return sludge lines, MM1 and MM2. | 1. Off, locked, tagged. | |

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|---|---|---|---|
| A. PRESTART UP PROCEDURES | | | |
| 2. Safety Inspection of Lime Storage and Feeding Equipment | 1. Inspect bin gates L1 and L2. | 1. Closed, locked, tagged. | |
| | 2. Inspect lime feeders. | 1. Off, tagged out of service. | |
| | 3. Inspect breakers for for lime feeders. | 1. Off, locked, tagged. | |
| | 4. Inspect lime slaker drives. | 1. Off, tagged out of service. | |
| | 5. Inspect breakers for lime slakers. | 1. Off, locked, tagged. | |
| | 6. Inspect water lines to lime slakers. | 1. Valves closed, tagged. | |
| | 7. Inspect motor control centers for lime pumps LP1 and LP2. | 1. Off, tagged out of service. | |
| | 8. Inspect breakers for lime pumps LP1 and LP2. | 1. Off, locked, tagged. | |
| | 9. Inspect valves L3, L4, and L5 in lime feed lines. | 1. Closed, tagged. | |

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|---|---|---|---|
| A. PRESTART UP PROCEDURES | | | |
| 3. Safety Inspection of Flocculation Aid Storage and Feeding Equipment | 1. Inspect motor control centers for transfer pumps TP1 and TP2. | 1. Off, tagged. | |
| | 2. Inspect breakers for transfer pumps TP1 and TP2. | 1. Closed, locked, tagged. | |
| | 3. Inspect motor control centers for flocculation aid feed pumps FP1, FP2, and FP3. | 1. Off, tagged. | |
| | 4. Inspect breakers for flocculation aid feed pumps FP1, FP2, and FP3. | 1. Closed, locked, tagged. | |
| | 5. Inspect valves F1, F2,F3,F4,F5,F6,F7, F8,F9,F10,F11,F12, F13,F14,F15,F16,F17, F18,F19,F20,F21,F22, F23, and F24 in flocculation aid feed lines. | 1. Clossed, tagged. | |
| | 6. Inspect breakers for mixers on storage tanks ST1 and ST2. | 1. Off, locked, tagged. | |



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| A. PRESTART UP PROCEDURES | | | |
| 4. Inspection of Up-Flow Clarifiers. | 1. Inspect clarifier wall. | 1. Should be clean and free of peeling paint and/or rust.<br>2. No excessive buckling. | |
| | 2. Inspect bottom of clarifier. | 1. Free of debris, no rust or peeling paint. | |
| | 3. Inspect center well walls. | 1. Clean free of peeling paint or rust.<br>2. Should be round within allowable tolerances.<br>3. Baffles, if present, should be securely welded and sturdy, and free of rust, etc. | |
| | 4. Inspect center well bracing. | 1. Turnbuckles should be tight and held in place by locking nuts. | |
| | 5. Inspect sludge collectors. | 1. Sturdy, all bracing secure.<br>2. Level, so as not to bind on tank bottom. | |
| | 6. Inspect flocculator blades. | 1. All blades straight and not bent.<br>2. All surfaces free of peeling paint and rust.<br>3. All blades securely welded or bolted in place.<br>4. Record dimensions of all blades. | |

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| A. PRESTART UP PROCEDURES | | | |
| | 7. Inspect rapid mixing impeller. | 1. All blades straight and not bent.<br>2. All surfaces free of peeling paint and rust.<br>3. All blades securely welded or bolted in place.<br>4. Record dimensions of all blades. | |
| | 8. Inspect effluent weirs and channel. | 1. Free of all debris and lime scale.<br>2. Weirs level, no bolts missing from weir plates. | |
| | 9. Inspect chemical feed lines in tank. | 1. All plugs and/or caps removed.<br>2. Lines adequately supported.<br>3. Sufficient unions or tees to simplify cleaning and maintenance. | |
| | 10. Inspect catwalks. | 1. Free of all debris.<br>2. All plates and/or grates securely held in place. | |
| | 11. Inspect handrails. | 1. Sturdy.<br>2. No sharp edges or rusted areas to cause cuts, infections. | |

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| A. PRESTART UP PROCEDURES | | | |
| 5. Up-Flow Clarifier Equipment Inspection. | 1. Inspect motors for rapid mixers, flocculators, and sludge collectors. | 1. Shafts turn easily.<br>2. Good alignment between motor shaft and reducer shaft.<br>3. All electrical boxes closed and gasketed.<br>4. All mounting bolts tight. | |
| | 2. Check all gear reducers for proper lubrication. | 1. See manufacturer's specification sheet.<br>2. Filled to proper level.<br>3. Be sure all drain plugs are tight. | |
| | 3. Inspect all variable speed drive units. | 1. Belts not frayed or worn.<br>2. Belts properly aligned. | |
| | 4. Inspect motor for return sludge pump. | 1. Shaft turns easily.<br>2. Coupling to pump properly aligned and in good repair.<br>3. Electrical box closed and gasketed.<br>4. All mounting bolts tight. | |

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| A. PRESTART UP PROCEDURES | | | |
| | 5. Inspect return sludge pump. | 1. Shaft rotates freely.<br>2. No scale on impeller or pump bowl. | |
| | 6. Inspect magnetic flow meter on return sludge line. | 1. Meter should have been calibrated recently.<br>2. Meter vault equipped with sump pump and ventillation to protect meter. | |
| | 7. Lubricate all bearings and bushings on main shafts. | 1. See Manufacturer's Data Sheet. | IX-3 |

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| A. PRESTART UP PROCEDURES | | | |
| 6. Chemical Storage and Feed Equipment Inspection | 1. Inspect lime screw conveyor from railroad car hopper to bucket elevators. | 1. Free of all debris.<br>2. Bearings properly lubricated and secure.<br>3. Dust covers in place. | |
| | 2. Inspect bucket elevators. | 1. Chain in good repair.<br>2. No pins missing.<br>3. All buckets securely attached to chain.<br>4. No excess slack in chain.<br>5. All dust covers securely attached. | |
| | 3. Inspect drive motors and reducers for screw conveyor and bucket elevator. | 1. Motors turn freely.<br>2. Motors and reducers properly aligned.<br>3. Couplings are serviceable.<br>4. Reducers are properly lubricated -- see Manufacturer's Data Sheet. | |

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| A. PRESTART UP PROCEDURES | | | |
| | 4. Inspect screw conveyors from top of bucket elevators to storage hoppers. | 1. Free of all debris.<br>2. Bearings properly lubricated and secure.<br>3. Dust covers in place. | |
| | 5. Inspect flocculation aid storage tanks, ST1 and ST2. | 1. Clean, free of all debris.<br>2. No holes in liners.<br>3. Drain valves D3 and D4 closed. | |
| | 6. Inspect mixers on ST1 and ST2. | 1. Shafts rotate freely, with no wobble.<br>2. All mounting bolts tight.<br>3. Impellers securely attached to shaft.<br>4. Electrical boxes closed and gasketed. | |
| | 7. Inspect day tanks DT1 and DT2. | 1. Clean, free of all debris.<br>2. No holes in liners.<br>3. Drain valves D5 and D6 closed. | |

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| A. PRESTART UP PROCEDURES | | | |
| | 8. Inspect transfer pumps TP1 and TP2. | 1. Pump and motor shafts rotate freely.<br>2. All mounting bolts tight.<br>3. Screens on suction lines clean.<br>4. All pipe connections tight to avoid air leaks. | |
| | 9. Inspect flocculation aid feed pumps FP1, FP2, and FP3. | 1. Motor shaft turns freely.<br>2. Drive belts not worn excessively.<br>3. Ball check valves are not worn.<br>4. Valve seats are round and uncracked.<br>5. Diaphram free of holes and properly seated in pump. | |
| | 10. Inspect lime feeders. | 1. Slide gate moves freely.<br>2. Belt not binding or dragging on housing.<br>3. Motor shafts rotate freely.<br>4. All sprockets and chains serviceable. | |

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| A. PRESTART UP PROCEDURES | | | |
| | 11. Inspect lime slakers. | 1. Motor shafts rotate freely.<br>2. Paddle shafts rotate freely, without excessive clearances.<br>3. Rakes rotate freely, without excessive play.<br>4. Torque controlled water valve is operable.<br>5. Grit collector serviceable, no pins or blades missing, sprockets not worn excessively.<br>6. Slaking chamber free of all debris. | V-1 |
| | 12. Inspect lime feed pumps, LP1 and LP2. | 1. Motor shafts rotate freely.<br>2. Drive belts not worn excessively.<br>3. Rotors turn, but with a constant resistance. | |

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|---|---|---|---|
| A. PRESTART UP PROCEDURES | | | |
| 7. Ordering of Chemicals | 1. Prepare specifications for each chemical used on the plant. | 1. This must be done before a purchase order can be issued.<br>2. If you do not have specification already prepared, see the American Water Works Association Standard as an example. | |
| | 2. Prepare a purchase requisition for each chemical. | 1. Generally you will buy a 3-6 month supply at one time.<br>2. State delivery schedules required.<br>3. State type of unloading equipment to be used, and the method of transportation (railroad car or truck). | |
| | 3. Forward requisition to purchasing agent. | 1. For competitive bids.<br>2. About three months <u>before</u> you need the chemicals. | IV-3<br>IV-4 |
| | 4. File purchase order. | 1. When returned from purchasing agent.<br>2. Where it can be easily found. | |

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| OPERATING PROCEDURES | STEP SEQUENCE | INFORMATION-OPERATING GOALS-SPECIFICATIONS | TRAINING GUIDE NOTE |
|---|---|---|---|
| A. PRESTART UP PROCEDURES | | | |
| | 5. Contact chemical supplier. | 1. Discuss details of chemical delivery.<br>a. Who to call.<br>b. What telephone numbers to use.<br>c. Find out what the approximate delivery times are.<br>2. Try to establish a good working relationship. | |
| | 6. Order necessary chemicals. | 1. Far enough in advance to that they will be on hand when you need them. | |

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| OPERATING PROCEDURES | STEP SEQUENCE | INFORMATION-OPERATING GOALS-SPECIFICATIONS | TRAINING GUIDE NOTE |
|---|---|---|---|
| B. START UP PROCEDURES | | | |
| 1. Receiving Chemicals | 1. Gage hoppers or storage tanks. | 1. Before unloading chemicals. | XII-2 |
| | 2. Assist supplier in unloading chemicals. | 1. Unloading is usually the supplier's responsibility, but your assistance will make the operation much smoother -- especially if this is the driver's first visit to the plant. | |
| | 3. Gage hoppers or storage tanks. | 1. After unloading is completed. | |
| | 4. Compute gallons or tons of chemical delivered. | 1. For liquids this is very accurate, and is the basis upon which the supplier should be paid.<br>2. For dry chemicals this is only approximate. | II-5 |
| | 5. Sign invoice indicating receipt of chemical, and retain your copies. | 1. Retain at least one copy for plant records.<br>2. Forward one copy to accounting or purchasing so the supplier can be paid.<br>3. If you received a dry chemical retain a copy of the weighing ticket, which will indicate total pounds shipped. | |

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|---|---|---|---|
| B. START UP PROCEDURES | | | |
| | 6. Collect sample of chemicals delivered. | 1. For analysis.<br>2. This is very important for controlling chemical feed rates. | X-1<br>X-2 |

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|---|---|---|---|
| B. START UP PROCEDURES (Continued) | | | |
| 2. Fill Up-Flow Clarifiers | 1. Unlock and energize all main breakers. | 1. To get power to the various motor control centers. | |
| | 2. Open effluent valves 5 and 6. | | |
| | 3. Tell filter operator he will be receiving flow from chemical section. | 1. So he is not surprised.<br>2. It will take about 3 hours to fill the up-flow clarifiers. | |
| | 4. Open influent valves 2 and 3. | 1. Slowly, so as to avoid damage to equipment. | |
| | 5. Turn on sludge collectors and observe for normal operation. | 1. Move slowly without jerks or binding. | |
| | 6. Turn on flocculators and observe for normal operation. | 1. Rotates smoothly without jerking.<br>2. No squeaking or grinding sounds. | III-3 |
| | 7. Adjust flocculator speed. | 1. By using varidrive.<br>2. Without other information, use last setting. | |

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| B. START UP PROCEDURES (Continued) | | | |
| | 8. Turn on rapid mixer and observe for normal operation. | 1. Rotates easily without binding or shaft deflection. | |
| | 9. Adjust rapid mixer speed. | 1. By using varidrive.<br>2. Without other information, use last setting. | III-3 |

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|---|---|---|---|
| B. START UP PROCEDURES (Continued) | | | |
| 3. Starting Lime Feed | 1. Calculate settings for lime feeders. | 1. Lime feed will depend on pH desired.<br>2. Use previous experience, or tables in Training Guide Section of this SOJP. | III-1<br>III-2 |
| | 2. Open valves L3 and L4 on lime feed lines. | 1. Never start a pump against a closed valve. | XII-3 |
| | 3. Turn on lime pumps LP1 and LP2. | 1. Before starting lime feed. | V-2 |
| | 4. Open water supply valves to Slaker No. 1 and No. 2. | | |
| | 5. Turn on lime slakers No. 1 and No. 2. | 1. Before starting lime feeders.<br>2. To prevent a torque overload. | V-2 |
| | 6. Open bin gates L1 and L2. | 1. So that lime can get to the feeders. | |
| | 7. Turn on and start Lime Feeders No. 1 and No. 2. | 1. Use a low feed rate to start with. This will avoid overloading the slakers and breaking a shear pin. | |

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|---|---|---|---|
| B. START UP PROCEDURES (Continued) | | | |
| | 8. Increase lime feed to desired rate. | 1. Slowly.<br>2. As the slakers come to normal operation.<br>3. This should take 15-20 minutes. | |
| | 9. Observe lime slurry discharge into up-flow clarifiers. | 1. To make sure everything is working OK.<br>2. Flow should be very white and constant. | |

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|---|---|---|---|
| B. START UP PROCEDURES (Continued) | | | |
| 4. Starting Ferric Chloride Feed | 1. Open valves F1,F2,F3, and F4. | 1. To fill day tank (DT1) from storage tank (ST1) by using transfer pump TP1. | |
| | 2. Turn on transfer pump TP1. | 1. To fill DT1.<br>2. Run pump TP1 until day tank TD1 is at desired level. | |
| | 3. Turn off transfer pump TP1. | | |
| | 4. Gage day tank DT1. | 1. So you can adjust feed rates at a later time.<br>2. Record on log sheet. | |
| | 5. Close valve F4. | | |
| | 6. Open valves F18 and F12. | 1. To fill day tank (DT2) from storage tank (STI) by using transfer pump TP1. | |
| | 7. Turn on transfer pump TP1. | 1. To fill day tank DT2.<br>2. Run pump TP1 until day tank DT2 is at desired level. | |
| | 8. Turn off transfer pump TP1. | | |

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| B. START UP PROCEDURES (Continued) | | | |
| | 9. Gage day tank DT2. | 1. So you can adjust feed rates at a later time.<br>2. Record on log sheet. | |
| | 10. Close valves F12, F18, F3, F2, and F1. | 1. It is good operation to keep all valves not being used CLOSED. | |
| | 11. Open valves F5,F6,F7 F8,F13,F14,F15, and F16. | 1. To pump from day tank DT1 with feed pump FP1.<br>2. To pump from day tank DT2 with feed pump FP2. | |
| | 12. Turn on feed pumps FP1 and FP2. | 1. To pump ferric chloride from day tanks DT1 and DT2 to up-flow clarifiers No. 1 and No. 2, respectively. | |
| | 13. Adjust ferric chloride feed to obtain desired dose. | 1. The ferric chloride is being used as a flocculation aid, and the dose required is usually 5-15 mg/l. See sample calculations in Training Guide Section. | |
| | 14. Observe ferric chloride entering up-flow clarifiers. | 1. To be sure pumps are working and lines are not plugged. | |

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| B. START UP PROCEDURES (Continued) | | | |
| 5. Process Instrumentation | 1. Turn on pH meters and recorders. | 1. Allow 30 minutes warm-up time. | XI-3 |
| | 2. Turn on turbidity meters and recorders. | 1. Allow 1 hour warm-up time. | |
| | 3. Turn on magnetic flow meters and recorders for return sludge lines. | 1. Allow 30 minutes warm-up time. | |
| | 4. Calibrate pH meters. | 1. Use a standard buffer solution that has a pH value that is close to the desired operating pH for the chemical treatment system. | III-1<br>III-2 |
| | 5. Calibrate turbidity meters. | 1. See Manufacturer's Data Sheet. | |

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| B. START UP PROCEDURES (Continued) | | | |
| 6. Solids Contact Operation | 1. Check sludge depth in up-flow clarifiers. | 1. Every 2 hours.<br>2. By using taps in side of tank, or any suitable sludge blanket locator. | X-3 |
| | 2. Open return sludge line valves S1, S2, S3, S5, S6, and S7. | 1. Before starting pumps. | |
| | 3. Start return sludge pumps SP1 and SP2. | 1. When sludge blanket is about 6 inches above pump suction. | |
| | 4. Adjust return sludge flow. | 1. To obtain a total solids concentration in the rapid mixing zone between 20,000 - 40,000 mg/l.<br>2. Approximately 5-10 percent of influent flow. | |

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| C. CONTINUOUS OPERATION | | | |
| 1. Two-hour Inspection Chemical Room | 1. Inspect lime feeders No. 1 and No. 2 for proper operation. | 1. No unusual noises.<br>2. No excessive vibrations.<br>3. Beam in balance. | |
| | 2. Open door on side of feeders. | 1. Observe for proper depth of lime on belt.<br>2. Observe belt for proper speed -- will depend on individual feeder. | |
| | 3. Inspect Lime Slakers No. 1 and No. 2 for proper operation. | 1. Paste of proper consistency.<br>2. Paddles rotating at proper speed -- approximately 70 / rpm.<br>3. Classifier rakes rotating at proper speed -- approximately 100 / rpm.<br>4. Grit collectors operating. | |
| | 4. Inspect lime feed pumps LP1 and LP2 for proper operation. | 1. Shafts rotating.<br>2. Motor at proper temperature -- check by holding hand on motor, it should not be too hot to touch. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| | | 3. No unusual noises from motors or pumps. | |
| | 5. Inspect ferric chloride feed pumps FP1, FP2, and FP3 for proper operation. | 1. Shafts rotating.<br>2. Motor at proper temperature -- check by holding hand on motor.<br>3. No leaking seals.<br>4. No unusual sounds or vibrations. | |
| | 6. Record settings for lime feeders. | 1. On operator's log. | XIII-1 |
| | 7. Record lime feeder totalizer readings. | 1. On operator's log. | XIII-1 |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| 2. *Chemical Room -- Abnormal Operations* | 1. *General Response.* | 1. *For this process to perform properly the chemical feed equipment must be working properly.*<br>2. *For any equipment malfunction in the chemical room, corrective action must be taken quickly.*<br>3. *Immediately contact plant maintenance staff and find out how long it will take to fix the equipment.*<br>4. *If estimated down time is more than about one hour, follow abnormal operations procedures.* | IV-2 |
| | 2. *See ABNORMAL OPERATIONS -- CHEMICAL ROOM.* | 1. *Lime feeder not operating.*<br>2. *Lime feeder beam not in balance.*<br>3. *Lime slaker not operating properly.*<br>4. *Lime pump not operating properly.*<br>5. *Ferric chloride pump not operating or leaking.* | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| 3. Two Hour Inspection-Process Equipment | 1. Inspect motors and drive units for rapid mixers for proper operation. | 1. Motors operating at normal temperature -- warm to the hand.<br>2. Reducer and varidrive operating quietly.<br>3. Chain tight, with no pins missing.<br>4. No unusual noises. | |
| | 2. Inspect motors and drive units for flocculators for proper operation. | 1. Motors operating at normal temperature - warm to the hand.<br>2. Reducer and varidrive operating quietly.<br>3. Chain tight, with no pins missing.<br>4. No unusual noises. | |
| | 3. Inspect motors and reducers on sludge collectors for proper operation. | 1. Motors operating at normal temperature -- warm to the hand.<br>2. Reducer operating quietly.<br>3. Chain tight with no pins missing.<br>4. No unusual noises. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| | 4. Inspect return sludge pumps and motors for proper operation. | 1. Motors operating at normal temperature -- warm to the hand.<br>2. Pump cool to the touch.<br>3. No noises indicating bearing failure. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| 4. *Process Equipment -- Abnormal Operations* | 1. *General response.* | 1. *In the event of mechanical failure corrective action must be taken. However, all equipment breakdowns do not cause great changes in effluent quality; and it may only be necessary to monitor the process more closely until maintenance can be completed.* | IV-2 |
| | 2. *See ABNORMAL OPERATIONS -- PROCESS EQUIPMENT.* | 1. *Rapid mixer not operational.*<br>2. *Flocculator not operational.*<br>3. *Sludge collector not operational.*<br>4. *Return sludge pump not operational.* | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| 5. Two-hour Inspection Process Control | 1. Read and record effluent pH. | 1. Take reading from recorder in control room.<br>2. Record on operator's log. | VII-3 |
| | 2. Read and record effluent turbidity. | 1. Take reading from recorder in control room.<br>2. Record in operator's log.<br>3. Should be less than 10 JTU, and a normal value is about 3-5 JTU. | VII-1 |
| | 3. Determine depth of sludge blanket and record. | 1. By using taps in side of clarifier, or a suitable sludge blanket locator.<br>2. Record in operator's log. | VII-2<br>X-3 |
| | 4. Read and record influent flow. | 1. Take reading from recorder in control room.<br>2. Record in operator's log. | |
| | 5. Read and record return sludge flow rate. | 1. Take reading from recorder in control room.<br>2. Record in operator's log. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| | 6. Determine and record effluent alkalinity. | 1. Determine both total (methyl orange) and phenolphthalein alkalinities.<br>2. The hydroxide ($OH^-$) alkalinity is usually a better process control parameter than pH, when operating at pH values greater than about 9.5.<br>3. Record in operator's log. | III-4 |
| | 7. Observe surface of clarifier. | 1. Should be clear of any floating solids.<br>2. The water should be very clear, but may have some color.<br>3. The sludge blanket should not be visible.<br>4. Visible floc particles should be relatively small.<br>5. Floc particles moving in a circular pattern, around the clarifier are an indication of a need for improved baffling in the clarification zone. | |
| | 8. Observe effluent flowing over the weirs. | 1. By experience, compare the actual flow to that indicated by the meter. This is a valuable cross check on the flow meter, and will tell you when the meter is very much out of calibration.<br>2. A visual estimate of effluent turbidity should be close to what the turbidity meter indicates. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| | | 3. If proper operation is being practiced, the water between the floc particles will be <u>almost</u> "crystal clear." | |

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| C. CONTINUOUS OPERATIONS (Continued) | | | |
| 6. *PROCESS CONTROL - ABNORMAL OPERATION* | 1. *General Reponse* | 1. *There are several indications that good process control is not being maintained. In some cases the operator must take corrective action very quickly; while other problems require a slower response.*<br><br>*The most important thing to do is determine the cause of the problem, then proper corrective action can be taken.* | IV-2<br>XI-3 |
| | 2. *See ABNORMAL OPERATIONS PROCESS CONTROL* | 1. *Effluent pH too high or too low.* | |
| | | 2. *Effluent turbidity too high.* | VIII-1 |
| | | 3. *Sludge blanket too deep.* | |
| | | 4. *Influent flow too high.* | |
| | | 5. *Return sludge flow too high or too low.* | |
| | | 6. *Effluent alkalinity too high or too low.* | |
| | | 7. *Surface of clarifier looks more turbid than normal, and many floc particles are visible.* | VIII-1 |
| | | 8. *Effluent flowing over weirs looks milky or cloudy.* | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| 7. Four-hour Inspection -- Chemical Room | 1. Perform all job steps listed for the two inspection. | 1. To assure proper operation. | |
| | 2. Gage ferric chloride day tank. | 1. So you can calculate the amount of ferric chloride fed. | |
| | 3. Compute amount of ferric chloride fed. | 1. Enter on operator's log. | II-3 |
| | 4. Compute ferric chloride dose. | 1. Enter on operator's log. | II-3 |
| | 5. Compute total pounds of lime fed. | 1. From readings taken from the lime feeders.<br>2. Enter on the operator's log. | II-6 |
| | 6. Compute lime dose. | 1. Enter on the operator's log. | II-6 |

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| C. CONTINUOUS OPERATIONS (Continued) | | | |
| 8. Four-hour Inspection -- Process Equipment | 1. Perform all job steps listed for the two hour inspection. | 1. To assure proper operation. | |
| | 2. Observe and record the dial setting of the rapid mixer varidrive. | 1. In the operator's log.<br>2. So you can determine the rpm. | V-3 |
| | 3. Record the rpm of the rapid mixer. | 1. In the operator's log.<br>2. Refer to the calibration curve. | |
| | 4. Observe and record the dial setting of the flocculator varidrive. | 1. In the operator's log.<br>2. So you can determine the rpm of the floccualtor. | V-3 |
| | 5. Record the rpm of the flocculator. | 1. In the operator's log.<br>2. Refer to the calibration curve. | |

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| C. CONTINUOUS OPERATION (Continued | | | |
| 9. Four-hour Inspection -- Process Control | 1. Perform all job steps listed for the two hour inspection. | 1. To assure proper operation. | VI-1 |
| | 2. Waste sludge as required. | 1. After determining depth of sludge blanket.<br>2. Sludge wasting will be controlled mostly by experience, but when feeding lime the sludge blanket should not be deeper than about three feet.<br>3. Be sure the sludge collectors are operating when wasting sludge. | IV-5 |
| | 3. Adjust lime feed -- if required. | 1. Normally, adjusting chemical feed rates every four hours is adequate for maintaining good effluent quality.<br>2. By checking the lime dose, flow, effluent pH, and effluent alkalinity you can easily tell whether the lime feed should be increased or decreased, and to what extent.<br>3. In some cases the influent alkalinity can increase considerably. This will require an increase in lime feed to obtain the same effluent pH. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| | 4. Adjust ferric chloride feed -- if required. | 1. Normally, adjusting the flocculation aid feed rate every four hours is adequate for maintaining good effluent quality; however, some plants may require more frequent changes in chemical feed rates.<br>2. Increase or decrease the ferric chloride feed rate to obtain the desired ferric chloride dose. | |
| | 5. Adjust the speed of the rapid mixers to give desired mixing. | 1. Usually, the speed of the mixers will have to be increased as the flow increases.<br>2. Experience with the individual plant is very important. | |
| | 6. Adjust the speed of the flocculators to give desired mixing. | 1. This is very important for proper floc formation.<br>2. Usually, the speed of the flocculators will have to be increased as the flow increases.<br>3. Experience with the individual plant is very important. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| 10. Once Per Shift-Chemical Room | 1. Perform all job steps listed for the 2-hr. inspections. | 1. To insure proper operation. | |
| | 2. Dust all equipment in operation. | 1. To keep clean, orderly appearance.<br>2. The operators are responsible for all equipment in service; therefore, this is their job. | |
| | 3. Inspect grit barrel and empty if necessary. | 1. All lime will have some grit, and the slaker will remove it from the paste. When the barrel catching the grit is about 1/3 full it should be emptied. | |
| | 4. Inspect Chemical Room Floor - Clean if Necessary. | 1. The operator is responsible for the appearance and operation of the plant. | |
| | 5. Record Total Pounds of Lime Fed per Shift. | 1. At end of each shift.<br>2. On operator's log. | |
| | 6. Record Total Gallons of Ferric Chloride Fed per Shift. | 1. At end of each shift.<br>2. On operator's log. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| 11. Once Per Shift -- Process Equipment | 1. Perform All Job Steps Listed for the 2-hr. and 4-hr. Inspections | 1. To insure proper operation. | |
| | 2. Inspect all motors, pumps, etc., and clean if required. | 1. To maintain good appearance. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| 12. Once per Shift -- Process Control | 1. Inspect and calibrate effluent turbidity meter. | 1. To assure good readings. | XI-1<br>XI-3<br>XI-? |
| | 2. Inspect and calibrate pH meter used in control room. | 1. To assure good process control. | XI-3 |
| | 3. Inspect and calibrate recording pH meters for effluent. | 1. To assure good process control.<br>2. THIS IS VERY IMPORTANT!!!!! | XI-3 |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| 13. Once Per Day | 1. Inspect the lubrication on all pumps, motors, and reducers. | 1. To minimize the maintenance costs.<br>2. To minimize down time.<br>3. See Manufacturer's Data Sheets for details. | |
| | 2. Compute total pounds of lime fed. | 1. Using data from the operator's log. | |
| | 3. Compute lime dose in mg/l. | 1. Record on Monthly Summary Sheet. | |
| | 4. Compute total gallons of ferric chloride fed. | 1. Using data from the operator's log. | |
| | 5. Compute ferric chloride dose in mg/l. | 1. Record on Monthly Summary Sheet. | |
| | 6. Compute average influent and effluent pH values. | 1. Record on Monthly Summary Sheet. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| | 7. Compute average influent and effluent alkalinities. | 1. Record on Monthly Summary Sheets. | |
| | 8. Compute average rapid mixer impeller speed. | 1. In rpm.<br>2. Record on Monthly Summary Sheet. | |
| | 9. Compute average flocculator speed. | 1. In rpm.<br>2. Record on Monthly Summary Sheets. | |
| | 10. Compute average influent and effluent turbidity values. | 1. Record on Monthly Summary Sheets. | |
| | 11. Compute total gallons of sludge wasted. | 1. Use data from operator's log. | |
| | 12. Compute total pounds of sludge wasted. | 1. Obtain suspended solids concentration from laboratory staff.<br>2. Record on Monthly Summary Sheets. | |
| | 13. Compute average daily flow. | 1. Record on Monthly Summary Sheets. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| 14. Weekly Activities | 1. Rotate all equipment not in service. | 1. Generally, several of the chemical feed pumps will be in a stand-by condition, and these should be put in service every other week.<br>2. This will provide a chance to perform preventive maintenance. | IX-2 |
| | 2. Thoroughly inspect all equipment taken out of service and placed on stand-by. | 1. To determine what maintenance must be performed. | IX-2 |
| | 3. Make repairs as required. | 1. Submit a work order to maintenance crew, or contact supervisior. | |
| | 4. Check lubrication schedules, and lubricate all equipment as required. | 1. See Manufacturer's Data Sheets. | |
| | 5. Cut grass in plant yard. | 1. If required.<br>2. Supervise laborer to be sure job is done properly. | |
| | 6. Polish floors in control and chemical rooms. | 1. Supervise laborer closely, and assist as required. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| 15. Monthly Activities | 1. Complete Monthly Summary Sheets, and and submit to your supervisor. | 1. This should include relatively detailed operating information, and monthly averages for all important values.<br>2. Include monthly average chemical costs, and any other information that will help the supervisor in budget planning. | |
| | 2. Prepare a brief monthly operator's report. | 1. Include comments about equipment maintenance difficulties, personnel problems, and any other comments that could be needed in the future. | |
| | 3. Check lubrication schedules. | 1. See Manufacturer's Data Sheets. | |
| | 4. Have all equipment lubricated as required. | 1. Coordinate with maintenance crew. | |
| | 5. Fill out your discharge monitoring Self-Reporting Form. | 1. This is required by law.<br>2. Your supervisor will probably take care of this, but be sure someone is doing it. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| 16. Quarterly Activities | 1. Send in the Discharge Monitoring Self-Reporting Forms. | 1. These forms are submitted every 90 days.<br>2. The addresses to which the forms are to be mailed are included in your Discharge Permit. | |

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| C. CONTINUOUS OPERATION (Continued) | | | |
| 17. Sampling Program | 1. Determine the type and frequency of sampling required for your plant. | 1. This information will be clearly stated in the NPDES discharge permit issued by the EPA or the State water quality control agency.<br>2. For a 10 MGD plant, a 24-hour composite sample collected at 2-hour intervals is usually specified for suspended solids, $BOD_5$, and pH.<br>3. Grab samples will be specified for fecal coliforms and residual chlorine.<br>4. Flow measurement will be specified as continuous. | |
| | 2. Collect samples as required. | | |
| | 3. Collect composite sample of waste sludge. | 1. When wasting sludge from the up-flow clarifiers.<br>2. Composite about 3-100 ml samples. The first just after you have started to waste sludge. The second about one-half way, and the third just before you stop wasting sludge. | |

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| D. ABNORMAL OPERATIONS - CHEMICAL ROOM | | | |
| 1. Lime Feeder Not Operating - Check Out. | 1. Check all breakers, switches, and control centers. | 1. To make sure someone has not turned off power by mistake. | |
| | 2. Check bin gates L1 and L2. | 1. To be sure they are open, so lime can get to the feeders. | |
| | 3. Open door on side of feeder and observe belt. | 1. It should be moving at normal speed. If the belt is not moving call maintenance for repairs, and use the other feeder to service both up-flow clarifiers. | |
| | 4. Inspect vertical slide gate. | 1. It should be open so that lime can be discharged onto the belt.<br>2. If closed, try to lift gently by hand. If the gate does not open notify maintenance crew and use the other feeder to service both up-flow clarifiers. | |

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| D. ABNORMAL OPERATIONS - CHEMICAL ROOM (Continued) | | | |
| 2. Lime Feeder Not Operating -- Set Up No. 2 Feeder Services Both Up-Flow Clarifiers. | 1. Turn off and tag the No. 1 feeder out-of-service. | 1. Indicate time, date, and reason for taking the feeder out of service, and then sign the tag. | |
| | 2. Close bin gate L1. | | |
| | 3. Shut down lime slaker No. 1. | 1. After it has flushed with service water for about 30 minutes, so that it will be clean and free of lime paste. | |
| | 4. Turn off lime pump L1. | | |
| | 5. Close valve L7. | | |
| | 6. Open valve L5. | 1. So lime pump LP2 can pump lime slurry to both up-flow clarifiers. | |
| | 7. Increase lime feed on the No. 2 lime feeder. | 1. So that Feeder No. 2 is not feeding total pounds of lime per hour required by both upflow clarifiers.<br>2. Do this slowly -- over a 30-minute period - to avoid overloading the slaker. | |

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| D. ABNORMAL OPERATIONS - CHEMICAL ROOM (Continued) | | | |
| | 8. Increase speed on lime pump LP2. | 1. If necessary.<br>2. To handle the increased flow of lime slurry. | |

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| D. ABNORMAL OPERATIONS - CHEMICAL ROOM (Continued) | | | |
| 3. Lime Feeder Beam Not in Balance. | 1. Inspect belt and vertical slide gate. | 1. To be sure both are operating. | |
| | 2. Increase feeder setting and observe vertical slide gate. | 1. The gate should open more to allow more lime to fall on the belt. | |
| | 3. Return feeder to original setting. | | |
| | 4. Balance the beam. | 1. By adjusting the weight. | |
| | 5. Observe beam for proper operation. | 1. Should stay balanced. | |
| | 6. Call Maintenance Crew for repair. | 1. If beam does not stay balanced. | |
| | 7. Shut down feeder for repairs. | 1. Tag out of service.<br>2. Flush slaker to prevent caking with lime paste. | |
| | 8. Change lime feed set up so that other feeder services both up flow clarifiers. | | |

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| D. ABNORMAL OPERATIONS - CHEMICAL ROOM (Continued) | | | |
| 4. Lime Slaker No. 1 Not Operating Properly. | 1. Inspect service water valve to slaker. | 1. It must be open. | |
| | 2. Remove cover and inspect paddles and rakes. | 1. These should be rotating at normal speed. | |
| | 3. Prepare to shut down slaker. | 1. If opening water valve does not solve problem.<br>2. If either the paddles or the rakes are not rotating. | |
| | 4. Close bin gate L1. | 1. To stop lime supply to feeder No. 1. | |
| | 5. Shut down lime feeder No. 1. | 1. Tag out of service and indicate maintenance problem with the slaker on the tag. | |
| | 6. Shut down Slaker No.1. | 1. After it has flushed with water, and is as clean as possible.<br>2. Tag out of service for maintenance. | |
| | 7. Turn off lime pump L1. | | |

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| D. ABNORMAL OPERATIONS - CHEMICAL ROOM (Continued) | | | |
| | 8. Close valve L7. | 1. To isolate the No. 1 Feeder, Slaker and Pump. | |
| | 9. Open valve L5. | 1. To the No. 2 lime feed system can service both up flow clarifiers. | |
| | 10. Increase feed rate on the No. 2 Lime Feeder. | 1. So that the total lime required is being fed by the No. 2 Feeder.<br>2. Do this slowly, so as not to overload the No. 2 Slaker (over about 30 minutes). | |
| | 11. Increase speed of lime pump LP2, if necessary. | 1. To handle the increased flow of lime slurry. | |
| | 12. Monitor effluent pH values on both upflow clarifiers. | 1. Very closely.<br>2. To maintain good process control. | |
| | 13. Adjust lime feed as required. | 1. To maintain desired pH value. | |
| | 14. Notify maintenance crew of trouble with lime slaker. | 1. As soon as possible. | |

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| D. ABNORMAL OPERATIONS - CHEMICAL ROOM (Continued) | | | |
| 5. Ferric Chloride Pump FP1, Not Operating or is Leaking. | 1. Observe pump and motor for proper operation. | 1. If everything appears normal the pump may be air locked. Open bleed-off valve carefully and then close after all air has been expelled from the pump and line. Observe ferric chloride discharge into up flow clarifier - it should appear normal. If there is still no flow the pump diaphram is punctured or a check valve is stuck, and the pump will have to be taken out of service.<br>2. If the diaphram actuator shaft is not moving the pump will have to be taken out of service and repaired.<br>3. If the pump is leaking take out of service and call maintenance crew for repair. | |
| | 2. Turn off flocculation aid pump, FP1. | 1. Tag out of service for maintenance.<br>2. Be sure to indicate the observed malfunction on the tag, include the date, and your name. | |
| | 3. Close valves F6 and F7. | 1. To isolate the pump requiring repairs. | |
| | 4. Open valves F19, F21, F22, and F23. | 1. So that stand-by pump FP2 can be put in service. | |

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| D. ABNORMAL OPERATIONS - CHEMICAL ROOM (Continued) | | | |
| | 5. Turn on stand-by flocculation aid pump, FP2. | | |
| | 6. Observe ferric chloride discharge into up flow clarifier No. 1 | 1. To verify that pump FP2 is pumping. | |
| | 7. Adjust pump F2. | 1. To give desired ferric chloride dose. | |

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| E. ABNORMAL OPERATIONS - PROCESS EQUIPMENT | | | |
| 1. Rapid Mixer Not Operational | 1. Determine source of mechanical failure. | 1. If the problem is with the motor, gear reducer, or drive assembly on top of the tank the unit can remain in service during repairs.<br>2. If the problem is with the shaft or the impeller the up flow clarifier will have to be taken out of service for repairs -- See SHUT DOWN PROCEDURES. | |
| | 2. Turn off power to rapid mixer. | 1. Lock and tag. | |
| | 3. Notify maintenance crew. | | |
| | 4. Increase flocculator speed slightly. | 1. To provide more energy for mixing.<br>2. Observe effluent quality closely and make adjustments as required. | |
| | 5. Increase ferric chloride dose. | 1. By about 50 percent.<br>2. To improve floc formation. | |
| | 6. Get rapid mixer drive repaired as quickly as possible. | 1. If extended down time is expected a compressed air line and diffusers should be installed as a temporary rapid mixer. | |

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| E. ABNORMAL OPERATION -- PROCESS EQUIPMENT (Continued) | | | |
| 2. Flocculator Not Operational | 1. Determine source of mechanical failure. | 1. If the failure occurred in the motor, gear reducer, or drive assembly the up flow clarifier can remain in service while repairs are being made.<br>2. If the failure was in the shaft or the impeller the unit will probably have to be taken out of service for repairs to be made -- See SHUT DOWN PROCEDURES. | |
| | 2. Turn off power to flocculator. | 1. Lock and tag. | |
| | 3. Notify maintenance crew. | | |
| | 4. Increase ferric chloride dose. | 1. By about 50 percent.<br>2. To improve floc formation. | |
| | 5. Change speed of rapid mixer. | 1. To try to get better effluent quality. First, increase speed of rapid mixer by about 20 percent and observe for better effluent quality. If no improvement occurs, reduce rapid mixer speed from original setting and observe for better effluent quality. This is trial and error, and changes should be made no more often than every 4 hours. | |

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| E. ABNORMAL OPERATIONS - PROCESS EQUIPMENT (Continued) | | | |
| | 6. Get flocculator drive repaired as quickly as possible. | 1. If extended down time is expected a compressed air line and diffusers should be installed to provide pneumatic flocculation. | |

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| E. ABNORMAL OPERATIONS - PROCESS EQUIPMENT (Continued) | | | |
| 3. Sludge Collectors Not Operational | 1. Contact Maintenance Crew immediately. | 1. This could be the start of big problems, and needs to be fixed quickly. | |
| | 2. Examine drive assembly and determine what is broken. | 1. So the maintenance crew can estimate the time it will take to repair the unit. | |
| | 3. Have maintenance crew estimate down time. | 1. If expected down time is greater than 36 hours, shut down the up flow clarifier and waste most of the sludge.<br>2. If expected down time is less than 36 hours shut off lime feed to that up flow clarifier. Then increase ferric chloride dose by about 300 percent to that upflow clarifier. | |

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| E. ABNORMAL OPERATIONS -- PROCESS EQUIPMENT (Continued) | | | |
| 4. Return Sludge Pump Not Operational | 1. Notify maintenance crew. | 1. This problem is not critical, although, some decrease in effluent quality may occur. | |
| | 2. Increase ferric chloride dose slightly. | 1. To improve floc formation.<br>2. About a 50 percent increase should be sufficient. | |

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| F. ABNORMAL OPERATIONS -- PROCESS CONTROL | | | |
| 1. Effluent pH Value Too High or Too Low. | 1. Collect grab sample of effluent. | 1. For pH analysis.<br>2. Use good sampling technique. | |
| | 2. Determine effluent pH. | 1. Use a properly calibrated pH meter.<br>2. To check the accuracy of the recording pH meter. | |
| | 3. Increase lime feed 10 percent. | 1. If effluent pH is too low. | |
| | 4. Decrease lime feed 10 percent. | 1. If effluent pH is too high. | |
| | 5. Adjust lime feed. | 1. After about 2 hours.<br>2. As required.<br>3. Until desired pH is obtained. | |

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| F. ABNORMAL OPERATIONS - PROCESS CONTROL (Continued) | | | |
| 2. Effluent Turbidity Too High. | 1. General comments. | 1. When proper process control is lost the effluent quality will decrease. The most important thing to do is determine what is wrong with the plant.<br>2. Has there been a change in -<br>a. Incoming flow characteristics.<br>b. Chemical feed rates.<br>c. Process equipment.<br>d. Process instrumentation. | |
| | 2. Check effluent turbidity and pH; also influent flow. | 1. A decrease in effluent pH will often result in an increase in effluent turbidity. This indicates that lime feed should be increased.<br>2. A sudden increase in flow will require increased chemical feed rates. If a high quality effluent is to be produced.<br>3. All three can be checked in the control room. | |
| | 3. Observe lime and ferric chloride discharges into the upflow clarifiers. | 1. If either flow looks unusual the problem is probably in the chemical room. A pump may have broken, or the lime feed system may need rapair. See ABNORMAL OPERATIONS - CHEMICAL ROOM for appropriate action. | |

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| F. ABNORMAL OPERATIONS - PROCESS CONTROL (Continued) | | | |
| | 4. Observe effluent flowing over weirs. | 1. To check the turbidimeter; it may just need calibration.<br>2. If cloudy it indicates coagulant doses are incorrect, or the mixer speeds are incorrect.<br>3. If there is excessive floc carry over the sludge blanket could be too high (see next section), or increased influent flow could be washing out more floc (if this is the case increase ferric chloride feed about 15 percent), or the flocculator speed could be incorrect (adjust if required). | |
| | 5. Inspect Chemical Room. | 1. To verify that lime feeder is properly operating. If it is not the effluent pH value should have indicated so.<br>2. To verify that ferric chloride pump is set at desired rate. | |
| | 6. Check depth of sludge blanket. | 1. Use the Percent Sludge Test or a suitable sludge blanket locator.<br>2. If the sludge blanket is too high excessive floc carry over will result in high effluent turbidity.<br>3. If the sludge blanket is at normal depth the problem is | |

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| F. ABNORMAL OPERATIONS - PROCESS CONTROL (Continued) | | | |
| | 7. Check return sludge flow. | 1. If return sludge flow is too low higher effluent turbidities often result.<br>2. Either increase the flow or fix the pump. | |
| | 8. Inspect rapid mixer and flocculator shafts. | 1. See ABNORMAL OPERATIONS - PROCESS EQUIPMENT. | |
| | 9. Collect grab sample of influent and perform jar test. | 1. If all above have detected nothing wrong with the plant, the characteristics of the influent may have changed enough to alter the coagulant doses needed to obtain proper coagulation/flocculation.<br>2. To determine required coagulant doses. | |

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| F. ABNORMAL OPERATIONS -- PROCESS CONTROL (Continued) | | | |
| 3. Sludge Blanket Too Deep | 1. Determine depth of sludge blanket. | 1. By using the Percent Sludge Test or any suitable sludge blanket locator. | |
| | 2. Turn off sludge collectors. | | |
| | 3. Check depth of sludge blanket. | 1. After about 2 hours.<br>2. If sludge blanket is lower, leave the collectors off and continue to check the blanket depth at one hour intervals.<br>3. Many people have found that running the sludge collectors continuously keeps the blanket too "fluffy," and results in high effluent turbidimeters. | |
| | 4. Waste as much sludge as practical. | 1. Coordinate with the operator in charge of sludge handling first. | |
| | 5. Turn off flocculator and rapid mixer. | 1. Only if the sludge blanket is very close to the weirs -- within 4 feet.<br>2. To reduce the turbulence in the basin. | |

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| F. ABNORMAL OPERATIONS -- PROCESS CONTROL (Continued) | | | |
| 4. Influent Flow Too High | 1. Verify that flow is being properly split between both up flow clarifiers. | 1. If not, determine why and report to your supervisor -- equalize flows.<br>2. If flow is equal, feed chemicals at required rate. | |

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| F. ABNORMAL OPERATIONS -- PROCESS CONTROL (Continued) | | | |
| 5. Return Sludge Flow Too High or Too Low | 1. Verify that flow meter is operating properly. | 1. By observation.<br>2. Have calibration checked. | |
| | 2. Adjust flow as required. | 1. The return sludge flow should be about 5 to 10 percent of the influent flow.<br>2. This should provide a total suspended solids concentration in the rapid mixer between 20,000-40,000 mg/l. | |

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| F. ABNORMAL OPERATIONS -- PROCESS CONTROL (Continued) | | | |
| 6. Effluent Alkalinity Too Low or Too High | 1. Check lime feed system. | 1. To determine if lime feed system is working properly. If not make required corrections -- See ABNORMAL OPERATIONS - CHEMICAL ROOM. | |
| | 2. Increase lime feed. | 1. If effluent alkalinity is too low.<br>2. About every two hours, until desired alkalinity is obtained.<br>3. Make only about 10 percent increases each time. | |
| | 3. Decrease lime feed. | 1. If effluent alkalinity is too high.<br>2. About every two hours until desired alkalinity is obtained.<br>3. Decrease feed by only about 10 percent each time. | |

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| F. ABNORMAL OPERATIONS - PROCESS CONTROL (Continued) | | | |
| 7. Surface of Clarifier is Turbid and Many Floc Particles are Visible. | 1. Check depth of sludge blanket. | 1. This usually indicates that the sludge blanket is too high. See ABNORMAL OPERATIONS - PROCESS CONTROL Sludge Blanket is too Deep. | |

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| F. ABNORMAL OPERATIONS -- PROCESS CONTROL (Continued) | | | |
| 8. Effluent Flowing Over Weirs Looks Milky. | 1. Check lime feed systems and lime dosage. | 1. This is usually an indication that the lime dose is inadequate. See ABNORMAL OPERATIONS - PROCESS CONTROL - Effluent Turbidity Too High. | |

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| G. SHUTDOWN PROCEDURES | | | |
| 1. Shut Down Lime Feed System | 1. Close bin gate, L1. | 1. Tag out of service. | |
| | 2. Shut down Feeder No. 1. | 1. Tag out of service. | |
| | 3. Shut down Slaker No. 1. | 1. After it has flushed with water for about 30 minutes.<br>2. Tag out of service. | |
| | 4. Turn off lime pump, LP1. | 1. After the lime line has been flushed with water for about 30 minutes.<br>2. Tag out of service. | |
| | 5. Close valves L7 and L3. | | |

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| G. SHUTDOWN PROCEDURES (Continued) | | | |
| 2. Shut Down Ferric Chloride Feed. | 1. Turn off metering pump FP1.<br>2. Close valves F7 and F8. | 1. Tag out of service | |

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| G. SHUTDOWN PROCEDURES (Continued) | | | |
| 3. Shutdown of Return Sludge Pump. | 1. Notify operator of sludge handling facilities that you will be wasting sludge. | 1. So he will be properly prepared. | |
| | 2. Close valve S3. | | |
| | 3. Open valve S4, and waste sludge from up flow clarifier. | 1. Continue wasting until the sludge concentration drops to about 4 percent. | |
| | 4. Turn off sludge pump SP1. | 1. Tag out of service. | |
| | 5. Close valves S1 and S2. | | |
| | 6. Turn off return sludge meter, MM1. | 1. Tag out of service. | |

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| G. SHUTDOWN PROCEDURES (Continued) | | | |
| 4. Transfer of Flow to Other Up Flow Clarifier. | 1. Open valve No. 1. | | |
| | 2. Close valve No. 2. | | |
| | 3. Increase lime feed on No. 2 Feeder. | 1. Slowly.<br>2. To handle total plant flow. | |
| | 4. Increase ferric chloride feed on metering pump, FP3. | 1. To handle total plant flow. | |
| | 5. Increase return sludge flow on No. 2 up flow clarifier. | 1. To about 5-10 percent of influent flow. | |

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| G. SHUTDOWN PROCEDURES (Continued) | | | |
| 5. Shut Down of the No. 1 Up Flow Clarifier. | 1. Open drain valve, D1. | | |
| | 2. Hose down sides of clarifier as it drains. | 1. To remove any sludge or calcium carbonate scale. | |
| | 3. Turn off rapid mixer. | 1. Tag out of service. | |
| | 4. Turn off flocculator. | 1. After it is out of the water.<br>2. Tag out of service. | |
| | 5. Open valves S1,S2, and S3. | | |
| | 6. Turn on sludge pump SP1. | 1. For a few minutes.<br>2. To clear line, meter, and pump of sludge. | |

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| G. SHUTDOWN PROCEDURES (Continued) | | | |
| | 7. Turn off sludge pump, SP1. | 1. Tag out of service. | |
| | 8. Close valves S1, S2, and S3. | | |
| | 9. Turn off sludge collectors. | 1. After tank has drained completely, and all sludge has been washed out.<br>2. Tag out of service. | |

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## I. OPERATING THEORY

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| I-1 (B.3.1.1.) | The major objectives of lime precipitation may be considered to be the removal of all suspended solids (including colloidal solids) and the removal of some dissolved compounds (mainly phosphorus compounds).<br><br>The importance of good coagulation and flocculation to effective chemical treatment cannot be overstated. If large tough floc are not formed there will be unusually high solids carry-over from the clarification zone, which will reduce treatment efficiency.<br><br>For this process to operate at maximum efficiency chemical feed rates and mixing must be properly controlled. In addition, a high quality effluent may not be obtained unless sludge is recirculated into the flash mixing compartment.<br><br>Regardless of the chemicals being used for treatment, the dose necessary to produce a high quality effluent will vary from plant to plant. When using lime as the primary coagulant it is usually necessary to maintain the effluent pH above a value of about 11.3.<br><br>Depending mainly on the alkalinity of the water being treated, the lime dose will usually range between 300 and 600 mg/l as CaO. The curves on the following page can serve as a useful guide for computing the initial lime feed rates.<br><br>It is important that alkalinity determinations be made on the influent to the chemical treatment module, since preceding unit processes can alter alkalinity considerably, especially activated sludge units.<br><br>Control of the power input to the basin -- how much the basin is mixed-is very important to good floc formation. If the water in the flocculation zone is undermixed, the particles will not stick together, and form large dense floc. Conversely, if the mixing is too great the floc formed will then be torn apart and good treatment will not be obtained. | |

| II. EDUCATIONAL CONCEPTS -- MATHEMATICS | | |
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| II-1 (B.3.1.1) | COMPUTATION OF LIME FEED RATES:<br>The following are known:<br>a. Lime purity - 92% CaO<br>b. Desired dose of lime - 375 mg/l as CaO<br>c. Flow - 2.1 MGD<br><br>$\frac{\text{lbs. lime}}{\text{day}} = \frac{375 \text{ lbs.}}{1{,}000{,}000 \text{ lbs.}} \times \frac{2{,}100{,}000 \text{ gal.}}{\text{day}} \times$<br><br>$\frac{8.43 \text{ lbs.}}{\text{gal.}} \times \frac{1}{0.92} = 7130 \frac{\text{lbs.}}{\text{day}}$<br><br>$\frac{\text{lbs. lime}}{\text{hour}} = \frac{7130 \text{ lbs.}}{\text{day}} \times \frac{1 \text{ day}}{24 \text{ hrs.}} = 297 \frac{\text{lbs.}}{\text{hr.}}$<br><br>Required time feed = $\frac{297 \text{ lbs.}}{\text{hr.}}$ | |

| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
|---|---|---|
| II-2 | COMPUTATION OF $FeCl_3$ FEED RATES:<br>The following are known:<br>a. Desired dose = 10 mg/l as Fe<br>b. $FeCl_3$ Syrup = 38% $FeCl_3$<br>c. $FeCl_3$ Syrup Specific Gravity - 1.38<br>d. Flow = 2.1 MGD<br><br>1. Compute dose as $FeCl_3$:<br>atomic weight of Fe = 55.85<br>atomic weight of Cl = 35.45<br>atomic weight of $FeCl_3$ = 162.20<br>therefore dose as $FeCl_3 = \frac{10 \text{ mg}}{1} \times \frac{162.20}{55.85}$<br>29.1 mg/l<br><br>2. Compute pounds of $FeCl_3$ per gallon of syrup.<br>$\frac{\text{lbs. of } FeCl_3}{\text{gal. of syrup}} = \frac{8.34 \text{ lbs.}}{\text{gal.}} \times 1.38 \times 0.38 =$<br><br>4.37 lbs. $FeCl_3$<br>gal. of syrup<br><br>3. Compute pounds of $FeCl_3$ required per day<br>$\frac{\text{lbs. } FeCl_3}{\text{day}} = \frac{29.1 \text{ lbs.}}{1{,}000{,}000 \text{ lbs.}} \times \frac{2{,}100{,}000 \text{ gal.}}{\text{day}}$<br>$\times \frac{8.34 \text{ lbs.}}{\text{gal.}} = \frac{510 \text{ lbs.}}{\text{day}}$<br><br>4. Compute gallons of $FeCl_3$ syrup to feed per day.<br>$\frac{\text{gallons of syrup}}{\text{day}} = \frac{510 \text{ lbs.}}{\text{day}} \times \frac{1 \text{ gal. syrup}}{4.37 \text{ lbs. } FeCl_3}$<br><br>116.70 gallons of syrup per day. | |

| II. EDUCATIONAL CONCEPTS -- MATHEMATICS (Continued) | | |
|---|---|---|
| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
| II-3 (C.7.3.1) | COMPUTATION OF $FeCl_3$ FEED RATES FROM DAY TANK READINGS: | |

Assume that the following are known:

a. Flow - 5.8 MGD

b. Day Tank holds 14.7 gallons per inch

c. Ferric Chloride syrup - 38% $FeCl_3$, has a specific gravity of 1.38, and has a $FeCl_3$ concentration of 4.37 pounds per gallon as before.

d. Day Tank reading at 8 AM = 57½ inches
Day Tank reading at Noon = 54½ inches

1. Compute pounds of $FeCl_3$ fed

$$\frac{\text{lbs. } FeCl_3}{4 \text{ hours}} = (57\tfrac{1}{2} \text{ inches} - 54\tfrac{1}{2} \text{ inches}) \times \frac{14.7 \text{ gal.}}{\text{inch}}$$

$$\frac{4.37 \text{ lbs.}}{\text{gal.}} = \frac{193 \text{ lbs. } FeCl_3}{4 \text{ hours}}$$

2. Compute pounds of water treated

$$\frac{\text{lbs. water}}{4 \text{ hrs.}} = \frac{5{,}800{,}000 \text{ gal.}}{\text{day}} \times \frac{8.34 \text{ lbs.}}{\text{gal.}} \times$$

$$\frac{4 \text{ hours}}{24 \text{ hrs/day}} = 8{,}080{,}000 \frac{\text{lbs. water}}{4 \text{ hrs.}}$$

3. Compute concentration of $FeCl_3$ fed:

$$\text{mg/l of } FeCl_3 = \frac{193 \text{ lbs. of } FeCl_3}{8{,}080{,}000 \text{ lbs. of water}} \times$$

$1{,}000{,}000 = 24$ mg/l $FeCl_3$

4. Compute concentration of Fe Fed:

$$\text{mg/l of Fe} = \frac{24 \text{ mg}}{1} FeCl_3 \times \frac{55.85}{162.2} = 8.3 \text{ mg/l Fe}$$

| II. EDUCATIONAL CONCEPTS -- MATHEMATICS (Continued) | | |
|---|---|---|
| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
| II-4 (C.13.12.1) | COMPUTE POUNDS OF DRY SLUDGE WASTED PER DAY:<br><br>The following are known:<br><br>a. Waste sludge flow = 37,691 gallons<br>b. Sludge concentration = 4.3% solids<br><br>lbs. of sludge = 37,691 gal. x $\frac{8.34 \text{ lbs.}}{\text{gal.}}$ x 0.043 =<br><br>13,517 pounds of dry sludge | |

| II. EDUCATIONAL CONCEPTS -- MATHEMATICS (Continued) | | |
|---|---|---|
| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
| II-5 (B.1.4.1) | COMPUTE GALLONS OF FERRIC CHLORIDE DELIVERED<br><br>KNOWING<br><br>1. First gage reading = 71½ inches from the lip of the storage tank to the surface of the ferric chloride syrup.<br><br>2. Second gage reading 17 inches<br><br>3. Diameter of storage tank = 7'0"<br><br>COMPUTE<br><br>1. Inches of ferric chloride added:<br><br>In. added = 1st reading - 2nd reading<br><br>= 71½ - 17<br><br>= 54½ inches<br><br>2. Feet of ferric chloride added:<br><br>Feet added = inches added divided by 12<br><br>= 54.5/12<br><br>= 4.54 feet.<br><br>3. Volume of ferric chloride added in cubic feet:<br><br>$V = 0.7854\ (Dia)^2(Depth)$<br><br>$= 0.7854\ (7^2)(4.54)$<br><br>= 174.72 cu.ft.<br><br>4. Volume of ferric chloride added in gallons:<br><br>Gallons added = $ft^3$ added x 7.48<br><br>= 174.72 x 7.48<br><br>= 1306.9 gallons of ferric chloride were delivered | |

II. EDUCATIONAL CONCEPTS -- MATHEMATICS

| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
|---|---|---|
| II-6 (C.7.5.1) (C.7.6.1) | COMPUTE TOTAL POUNDS OF LIME FED AND LIME DOSE | |

KNOWING

A. Readings on Feeder No. 1

1. 12 noon = 178461
2. 4 PM = 179987

B. Readings on Feeder No. 2

1. 12 noon = 292,496
2. 4 PM = 294,796

COMPUTE

A. Total Pounds of Lime Feed

lbs. CaO = (179987 - 178461) + (294796 - 292496)

= 1526 + 2300

= 3826 lbs. CaO in 4 hrs.

B. Average Lime Dose (mg/l)

$$\text{Dose (mg/l)} = \frac{\text{lbs. Fed} \times 24}{Q(\text{MGD}) \times 8.34 \times T(\text{hrs.})}$$

$$= \frac{3826 \times 24}{9.7 \times 8.34 \times 4.0}$$

= 284 mg/l

| III. EDUCATIONAL CONCEPTS -- SCIENCE | | |
|---|---|---|
| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
| III-1 (B.3.1.1) (B.5.4.1) | Chemistry<br><br>pH -- What the term means and how to make pH determinations | Kerri-Sec. 14, pp. 121-126<br><br>Sawyer and McCarty pp. 314-319<br><br>Standard Methods pp. 267-281 |
| III-2 (B.3.1.1) (B.5.4.1) | Fundamental Principles of Chemistry | Cox, C.R., Laboratory Control of Water Purification, Rueben J. Donneley Corp., New York, 1946.<br><br>Fair, Heyer, and Okum 28-1, to 28-49<br><br>Sawyer and McCarty, Part I |
| III-3 (B.2.7.1) (B.2.9.1) | Fundamentals of Coagulation, Flocculation, and Sedimentation | Fair, Geyer, and Okum 26-1 to 26-12<br><br>Cox, pp. 163-206<br><br>Culp and Culp, pp. 17-50<br><br>Sawyer and McCarty, pp. 341-346 |
| III-4 (C.5.6.1) | Alkalinity -- Penolophthalein and Methyl Orange | Standard Methods pp. 52-56<br><br>Cox, pp. 115-130<br><br>Sawyer, and McCarty pp. 327-340 |

| IV. EDUCATIONAL CONCEPTS -- COMMUNICATIONS | | |
|---|---|---|
| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
| IV-1 (C.1.6.1) (C.1.7.1) | Any entries in the daily operator's log should be neatly written in pencil. | |
| IV-2 (C.2.1.1) (C.4.1.1) (C.6.1.1) | Any time there is a change in standard operating procedure the operator coming on shift, and the supervisor, should be notified. The communication should be both verbal and by a note. The note should be dated, indicated what changes were made and why, and signed. | |
| IV-3 (A.7.3.2) | It usually takes several weeks to process a purchase order for chemicals and plant equipment. For this reason it is very important that requirements be anticipated well in advance. A letter giving the exact specifications of the items needed should be sent to the purchasing agent as far in advance as possible. | |
| IV-4 (A.7.3.2) | The importance of clear, concise writing in all communications cannot be overemphasized. | |

| IV. EDUCATIONAL CONCEPTS -- COMMUNICATIONS (Continued) | | |
|---|---|---|
| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
| IV-5 (C.9.2.1) | You must notify personnel operating the sludge handling facilities before you start to waste sludge. Indicate the approximate concentration and the total gallons to be wasted. | |

| V. PROCESS EQUIPMENT | | |
|---|---|---|
| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
| V-1 (A.6.11.1) | On this slaker the bearings are protected from the very corrosive lime paste by a seal. Service water is applied behind the seal and is forced out between the seal and the shaft. This continuously forces the lime paste away from the bearing. It is important that the seal be in good repair, and that at least 30 psig service water is available. | |
| V-2 (B.3.3.1) (B.3.5.1) | All equipment downstream of the lime feeders should be started (or turned on) before the feeders are started to prevent plugging feed lines, etc. | |
| V-3 (C.8.3.1) (C.8.5.1) | Most varidrives have an adjusting handle and pointer coupled to a scale that reads from 0 to 9. The dial setting is not directly related to rpm; therefore, a calibration curve must be made.<br><br>Any time maintenance or adjustments are made on the varidrive a new calibration curve should be made. | |

| VI. PROCESS FLOW -- CHARACTERIZATION | | |
|---|---|---|
| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
| VI-1 (C.9.1.1) | **Typical Effluent Quality Data**<br><br>1. For Activated Sludge Effluent<br>TSS = 9 mg/l<br>$BOD_5$ = 9 mg/l<br>COD = 45 mg/l<br>TOC = 17 mg/l<br>TOD = 22 mg/l<br>$NH_3$-N = 0.2-15 mg/l<br>Org. N = 1.1 mg/l<br>$NO_2$ & $NO_3$-N = 0.5-15 mg/l<br>Total P = 9.4 mg/l<br>M.O. Alkalinity = 60-250 mg/l as $CaCO_3$<br>P. Alkalinity = 0 mg/l as $CaCo_3$<br>Specific Conductance = 700 microhms<br>pH = 7.1<br>MPN = $1 \times 10^4$ per 100 ml<br>Fecal Coliforms = $1 \times 10^3$ per 100 ml<br>Total Plate Count = $1 \times 10^6$ per 1 ml<br>Turbidity = 3 JTU | |

VI. PROCESS FLOW - CHARACTERIZATION (Continued)

| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
|---|---|---|
| VI-1 (C.9.1.1) | 2. For Solids Contact, Up Flow Clarifier Effluent<br>TSS = 7 mg/l<br>$BOD_5$ = 1 mg/l<br>COD = 23 mg/l<br>TOC = 12 mg/l<br>TOD = 17 mg/l<br>$NH_3$-N = 0.5-15 mg/l<br>Org. N = 0.7 mg/l<br>$NO_2$ & $NO_3$-N = 0.5-15 mg/l<br>Total P = 0.1 mg/l<br>M.O. Alkalinity = 250 mg/l as $CaCO_3$<br>P. Alkalinity = 210 mg/l as $CaCO_3$<br>Specific Conductance = 1700 microhms<br>pH = 11.5<br>MPN = 0 per 100 ml<br>Total Plate Count = 10 per 1 ml<br>Turbidity = 1.6 JTU | |

| VII. PROCESS CONTROL | | |
|---|---|---|
| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
| VII-1 (C.5.2.1) | Effluent turbidity is one of the most important process control parameters that can be used. The effluent should be very clear, although some floc carry-over will occur. The effluent turbidity should always be below 6 JTU and usually will be less than 2 JTU. | |
| VII-2 (C.5.3.1) | The sludge in tap "A" should be very heavy and thick, producing a 100% reading on the Percent Sludge Test. If the sludge becomes too thin (less than 4% solids by weight) solids handling costs will increase; however, the sludge should not be allowed to get too thick (greater than 8%) or it may overload the sludge collectors. | |
| VII-3 (C.5.1.1) | When lime is used as the primary coagulant effluent pH is the major process control -- be sure the meter is PROPERLY calibrated. | |

VIII. ABNORMAL OPERATION: TROUBLE SHOOTING

| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
|---|---|---|
| VIII-1 (C.6.2.2) | Excessive carry-over of large floc generally indicates that the sludge blanket is too high and is becoming unstable. Check for sludge in Tap "E." If there is a significant amount of sludge in Tap "E" do the following:<br><br>1. Stop sludge collectors for several hours.<br>2. Reduce flow to the basin if possible.<br>3. Waste as much sludge as practical.<br><br>Excessive carryover of fine floc usually indicates a breakdown in chemical treatment. The following should be checked immediately and corrected:<br><br>1. Lime feeder operating improperly.<br>2. Lime slaker operating improperly.<br>3. Lime pump has stopped.<br>4. Lime line is plugged.<br>5. Ferric chloride day tank is empty.<br>6. Ferric chloride pump is not pumping.<br>7. Flash mixing and/or flocculation zone mixers are not at correct speeds.<br>8. Check for an increase in influent alkalinity -- this will require a higher lime dose. | |

| IX. MAINTENANCE PRACTICES | | |
|---|---|---|
| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
| IX-1 (C.14.1.1) | All lime feed equipment should be cleaned weekly. The cleaning procedures will vary depending on the particular plant set-up. One very good way to clean pumps and lines is by pumping several gallons of 3:1 dilute HCl through the lines. This will effectively remove all scale from the pump and the lime feed line. In some cases using a "Roto Router" on the lime lines weekly will prove more effective -- generally only at the very large plants. | |
| IX-2 (C.14.2.1) | The chemical feed equipment will generally be designed to handle a flow 2-4 times greater than the average daily flow. This means that about half of the chemical feed equipment will be out of service most of the time. All equipment should be rotated weekly. Equipment taken out of service should be cleaned, inspected, and repaired if necessary. | |
| IX-3 (A.5.7.1) | Proper lubrication is very important to the operation of the plant. You may find it is very worthwhile to retain a lubrication engineer from a large oil company to set up the lubrication schedule and provide advice on the types of greases and oils to be used. | |

| X. LABORATORY PRACTICES | | |
|---|---|---|
| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
| X-1 (B.1.6.1) | Iron Determinations of Ferric Chloride Syrup -- if this cannot be done obtain the percent of ferric chloride in the syrup from the supplier. | Standard Methods pp. 210-215<br><br>Methods for Chemical Analysis of Water and Wastes, 1971, EPA, WQO, Analytical Quality Control Laboratory, 1014 Broadway, Cincinnati, Ohio 45202, pp. 98-108. |
| X-2 (B.1.6.1) | Analysis of Lime -- Sugar Test and Ellm's Test. | Hoover, C.P., Water Supply and Treatment, Bulletin 211, National Lime Association, Washington, D.C. 193-194. |
| X-3 (B.6.1.2) (C.5.3.1) | PERCENT SLUDGE TEST<br><br>To determine the relative amount of sludge at any given level, take a glass, one pint milk bottle (or other suitable container) and calibrate the bottle from 0 to 100 percent full. Fill the bottle with a representive sample of sludge and let the bottle stand quietly for 10 minutes. Read the interface between the top of the sludge and the water to determine percent sludge. This should be done for Taps A, B, C, D, and E every two hours. | |

| XI. INSTRUMENTATION -- AUTOMATION | | |
|---|---|---|
| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
| XI-1 (C.5.8.1) (C.12.1.1) | Sometimes grit will collect in the center tube of the surface scatter turbidimeters. Increasing the flow to maximum for a few minutes will usually wash out the grit which has accumulated. The turbidimeter should then be recalibrated and placed back in service. When calibrating the instrument be sure the smooth side of the calibration plat is facing up. | |
| XI-2 (C.12.1.1) | The feed line to the instrument should be acid flushed (with 3:1 HCl) weekly to remove carbonate scale. | |
| XI-3 (C.6.1.1) (C.12.1.1) (C.12.2.1) (C.12.3.1) | Proper calibration and maintenance of instrumentation is one of the most important activities in the plant, since the instruments are vital for good process control. | |

## XII. SAFETY PRACTICES

| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
|---|---|---|
| XII-1 (A.1.1.1) | The safety inspection is the most important thing an operator will do when putting any piece of equipment into service -- pay attention to all details. | |
| XII-2 (B.1.1.1) | Both quicklime and ferric chloride are very corrosive and caution should be excercised anytime these chemica's are being handled. Do not get in eyes -- if so, flush with large volumes of clear water. Avoid prolonged contact with the skin. Do not add water to quicklime in storage, as this produces a great amount of heat.<br><br>Any time lime or ferric chloride is being handled around the plant, the persons involved should be wearing rubber gloves and a face mask or safety goggles. | |
| XII-3 (B.3.2.1) | Starting a positive displacement pump against a closed valve can cause a line to rupture, damage the pump, or in extreme cases injure personnel. ALWAYS BE SURE ALL DOWNSTREAM VALVES ARE OPEN. | |

| XIII. RECORDS AND REPORTS | | |
|---|---|---|
| TRAINING GUIDE NOTE | TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES | REFERENCES/INSTRUCTIONAL RESOURCES |
| XIII-1<br>(C.1.6.1)<br>(C.1.7.1)<br>(C.13.2.1)<br>(C.13.5.1) | SEE attached log sheet and monthly summary sheet. | |

DALLAS WATER UTILITIES DEPARTMENT
WATER RECLAMATION RESEARCH CENTER

DAILY OPERATING RECORD
NO. 1 UPFLOW CLARIFIER

Date _____

| | | | FLOW | | | AGIT. SPEED RPM | | | | | | SLUDGE TAPS | | | | | CHEMICAL FEED | | | | | | | | ALKA. | | TEMP. | | pH | | TURB. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | Source | Run | Flow Rate GPM 303 | Sldg Rtrn GPM 333 | Sldg Wste GPM 338 | Upper React Zone | | Lower React Zone | | Settling Zone | | | | | | | Lime #309 | | Lime #309 | | Coag. Aid #308 | | Coag. Aid #308 | | | | | | | | | |
| | | | | | | Dial | RPM | Dial | RPM | Dial | RPM | A | B | C | D | E | Dial | lb/hr | Lbs | mg/l | Dial | G/h | ins | mg/l | Inf | Eff | Inf | Eff | Inf | Eff | Inf | Eff |
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| AVERAGE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

DALLAS WATER UTILITIES DEPARTMENT
WATER RECLAMATION RESEARCH CENTER
MONTHLY SUMMARY SHEET
NO. 1 UPFLOW CLARIFIER

PERIOD _____

| Date | Run No. | Source | FLOW | | | AGITATOR SPEED | | | CHEMICALS USED | | | | | | | | TESTS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Feed Rate GPM | Sludge Return GPM | Sludge Wasted GAL | Upper Zone RPM | Lower Zone RPM | Sett. Zone RPM | HYDR. LIME | | FeCl$_3$ | | LIQ. ALUM | | COAG. AID | | P.Alk. | | M.O.Alk. | | Turbidity | | pH | | Temp. |
| | | | | | | | | | Total Lbs | Mg per L. | Total Lbs. | Mg per L. | Total Lbs. | Mg per L. | Total Lbs. | Mg per L. | Inf. | Eff. | Inf. | Eff. | Infl. | Eff. | Inf. | Eff. | °C |
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